Strontium biokinetic model for mouse-like rodent

Georgy Malinovsky, Ilia Yarmoshenko, Michael Zhukovsky

Institute of Industrial Ecology UB RAS,

S. Kovalevskoy Str., 20, 620219, Ekaterinburg, Russia, e-mail: Georgy@ecko.uran.ru

One of the most significant radiation accidents in the history was that appeared at Mayak nuclear plant in 1957, which resulted in radioactive contamination of large territory (East-Ural Radioactive Trace, EURT). Currently, after a considerable period of time after the accident, the main dose contributing radionuclide in EURT is ^{90}Sr, which is a bone-seeking element.

Non-human EURT biota has been studied for a long time and considerable amount of radiobiological information as well as data on radiation exposure effects on mouse-like rodents population were collected. At the same time dosimetry of wild animals, particularly small mammals, was not paid enough attention.

The objective of the study is development of strontium biokinetic model for murine rodents that is based on published experimental data and appropriate for internal dose assessment of small animals inhabiting EURT territories.

For development of strontium biokinetic model for murine rodent the analogous ICRP model for human were used with some simplification. The model was reduced by abandoning the division of gastrointestinal system into compartments and combining other soft tissues into single model organ. The skeleton is modeled by two compartments with slow and fast exchange rates.

Published data on intake and retention of strontium in body of laboratory mice (more than 20 sources of information) were analyzed.

Fig. 1. Strontium biokinetic model for mouse-like rodent (five compartments - Blood, Gastrointestinal tract, Soft tissues, Skeleton, Urinary bladder, and eleven transfer rates).

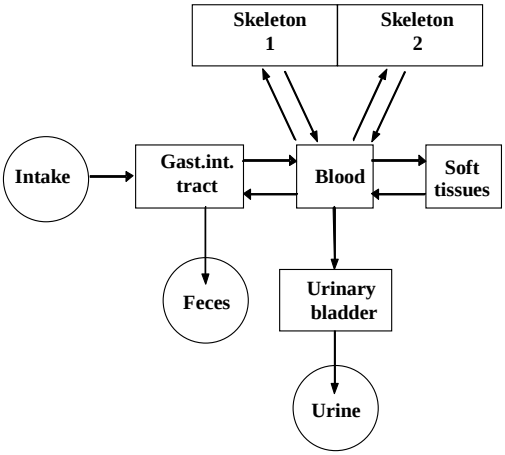


Fig. 2. Retention of strontium in skeleton of laboratory mice and rats with time since acute injection (% of intake) according to published data.

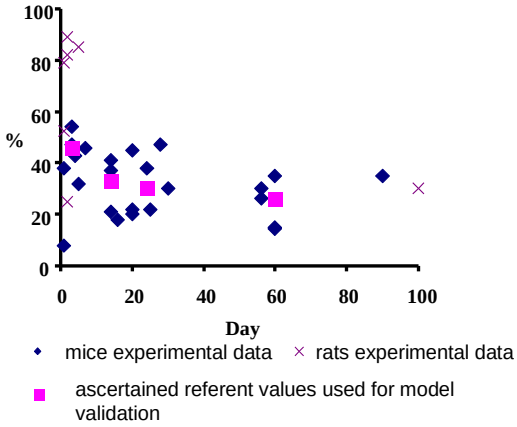


Table. 1. Transfer rates linking the donor and receiver compartments of organism in developed model.

Organ donor ->Organ receiver	Value, day^{-1}
GIT->Blood	3.0E+00
Blood ->GIT	2.0E-01
Blood ->Bone_1	4.0E+00
Bone_1 ->Blood	5.0E-01
Blood ->Bone_2	1.0E+00
Bone_2 ->Blood	6.0E-03
Blood ->UBCont	2.0E+00
GIT ->Feces	3.0E+00
Blood ->SoftT	4.0E+00
SoftT ->Blood	1.0E+00
UBCont ->Urine	4.0E+00

Case of acute exposure modeling

Fig. 3. Model retention with standard error estimated using experimental data from Fig. 2.

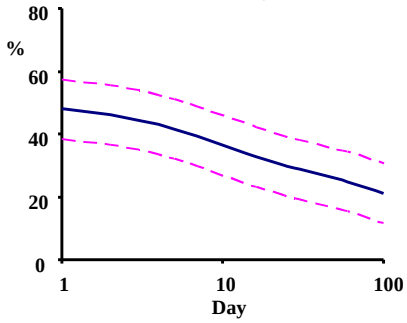
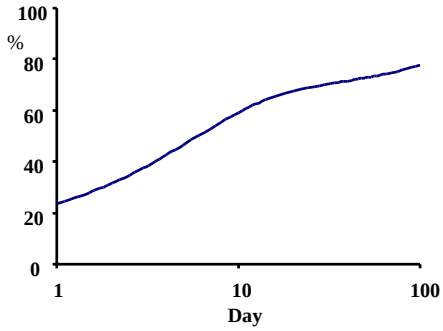


Fig. 4. Model total excretion.



Case of chronic exposure modeling (daily intake 1 Bq)

Fig. 5. Activity of skeleton.

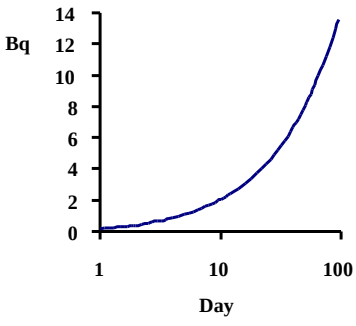
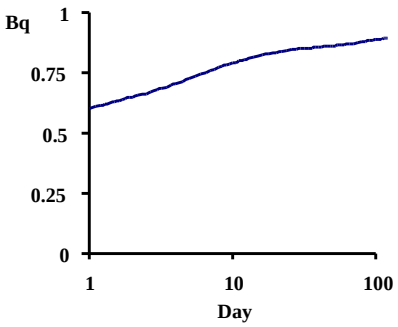


Fig. 6. Daily excretion.



Conclusion

Application of developed model allows estimation of strontium distribution by organs and tissues both in the cases of acute and chronic exposure with dependence of strontium activity in organs of murine rodent on time.

The strontium biokinetic model will be used for internal dose assessment for murine rodents inhabiting EURT territories. Comparison of dose estimations with studied effect of radiation exposure constitutes radiobiological basis for radiation protection of EURT biota.

The research has been made under the financial support of Ural Branch of Russian Academy of Sciences, projects 12-M-24-2016.